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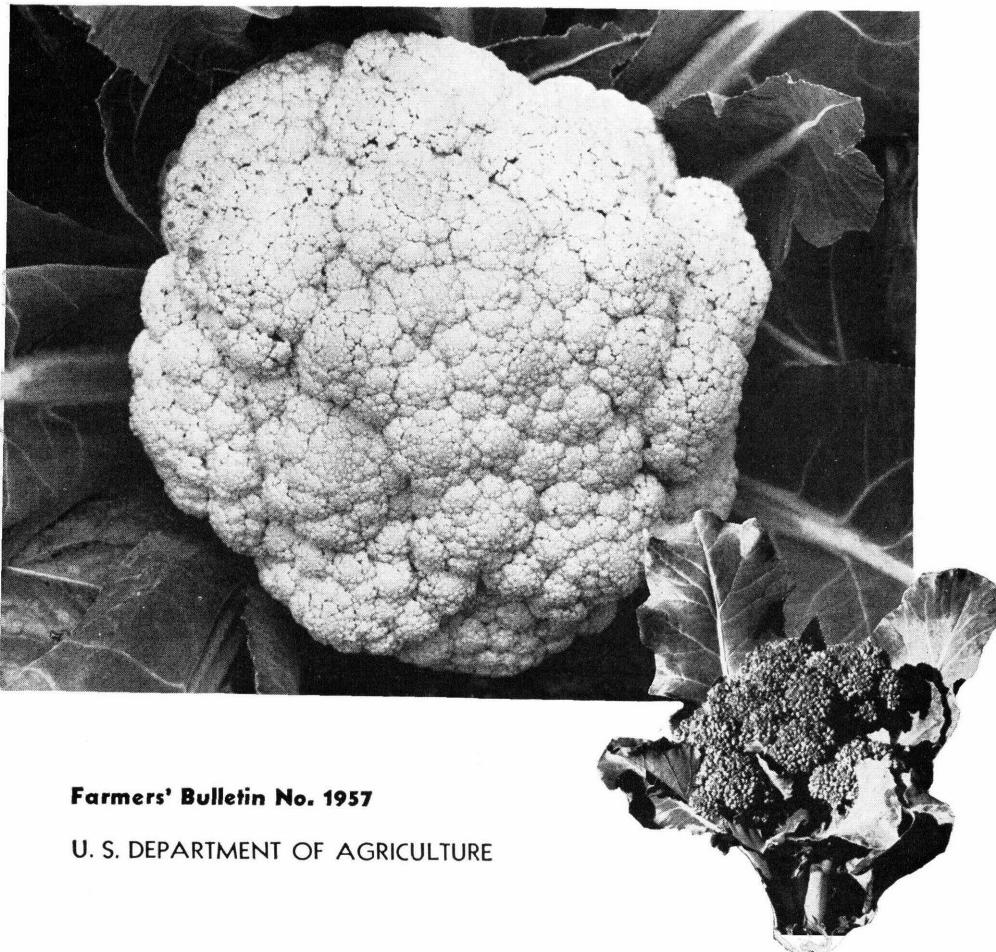
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Cauliflower and Broccoli

VARIETIES AND CULTURE



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Cauliflower and Broccoli

VARIETIES AND CULTURE

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Cauliflower, the so-called heading broccoli, and sprouting broccoli are all members of the cabbage group and therefore are closely related botanically. Heading broccoli, sometimes called cauliflower-broccoli, is in effect a late, long-season cauliflower. Both belong to the same species and variety. Sprouting broccoli may be described as a green-headed, elongated, branching form of cauliflower (fig. 1). The term "heading broccoli" as generally used is somewhat confusing, since both the plant and its head resemble those of cauliflower much more than those of sprouting broccoli. Few people would fail to distinguish heading broccoli from sprouting broccoli, but even a trained horticulturist might confuse heading broccoli with the late varieties of cauliflower.

The chief difference between varieties of cauliflower and those of heading broccoli is that the broccoli requires a longer time from planting to reach maturity. It seems more logical and less confusing to consider the varieties of heading broccoli as late, long-season varieties of cauliflower and to apply the term "broccoli" only to the sprouting form. In this bulletin, therefore, cauliflower will be used to include all the varieties of cauliflower and of the so-called heading broccoli, or cauliflower-broccoli. Broccoli will be used only for the sprouting form.

On the basis of season of production the important cauliflower-growing States may be divided into four groups. These groups are (1) spring—California, Oregon, and Washington; (2) summer—New Jersey, New York, and Colorado; (3) fall—New York (Long Island), Michigan, and Oregon; and (4) winter—California, Arizona, Texas, and Florida. Small acreages are grown in other States.

Although it has been grown in Europe for centuries, broccoli has become an important vegetable crop in this country only since 1925. It is now grown extensively and is very much in demand in certain markets. Much broccoli is now grown in the Southern and South Atlantic States for shipment to northern markets. It is much more widely grown than cauliflower.

Broccoli is well adapted for freezing, and a large amount of it is now marketed as a frozen product. Some of the newer varieties are better adapted to freezing than the older ones. The green heads of broccoli are a good source of vitamins and minerals. In this respect broccoli is superior to cauliflower as a food product.

¹ Retired Nov. 30, 1956.



FIGURE 1.—A head of broccoli ready to harvest.

CLIMATIC ADAPTATION AND CULTURAL REQUIREMENTS

Cauliflower is one of the most difficult of the vegetable crops to grow successfully. Several very important conditions must be met for profitable production. They are soil of good fertility, rich in organic matter and high in nitrogen; general low temperatures during the growing season, but freedom from frosts; soil moisture at a fairly high level throughout the growing season; and a relatively high atmospheric humidity. Except under these conditions the crop is likely to be a failure. Commercial production of cauliflower is confined to districts where the atmosphere is cool and humid because of latitude, elevation, or nearness to large bodies of water. The importance of these factors is shown by the concentration of the industry in the coastal districts of California and Washington, on Long Island, N. Y.,

and in the mountain districts of Colorado, and in western New York.

Broccoli is much less exacting in its requirements than cauliflower. It can be grown therefore in many places where cauliflower fails to make a crop. Its wider range of adaptation makes it a desirable home-garden vegetable crop where cauliflower cannot be grown.

Cauliflower and broccoli are attacked by many of the same diseases and insects that affect other members of the cabbage group; hence, they should not be grown on land that has been planted to cabbage, turnip, kale, and related crops during the preceding 4 or 5 years.

CAULIFLOWER VARIETIES

There is much confusion in the names given to cauliflower varieties and strains. The origin of some of these is obscure. Some varieties that are not well fixed as to type are sold under several names. There are many more names in the trade than there are varieties. The uniformity and heading ability of a strain are more important than its varietal designation.

One of the most important differences in strains of cauliflower is the period required for a crop to reach maturity. Some early strains of the Snowball type become marketable in 50 to 55 days after being transplanted to the field. Some midseason strains of the Danish Giant type require 70 to 80 days. Late types, which are grown mostly in the Pacific Coast States, may require more than 150 days.

Cauliflower varieties differ in plant size, in size, color, and other foliage characteristics, and in the manner in which the inner leaves enclose the developing curd protecting it from light. Such protection is very important in preventing discoloration of the curd as a result of exposure to light. Poor strains have an undesirable tendency to develop small leaves that extend out through the branches of the head, spoiling their salability.

Some of the best of the cauliflower varieties are described below.

Early to Late Varieties

Early Snowball is one of the earliest and probably the most important of the early strains. It requires 50 to 60 days to mature. The plants are dwarf, compact, and quick-growing, with upright, medium-green leaves that turn outward at the tips. The heads are uniform, compact, solid, ivory white, and of excellent quality and flavor. It is especially desirable in districts having a short growing season. There are numerous strains and selections of Snowball offered in the seed trade.

Super Snowball is one of the earliest maturing varieties, requiring 55 to 60 days to mature. The plants are of the short-leaved or dwarf type. The leaves are somewhat spreading, longer than in Early Snowball, and blue green. The heads are medium in size, solid, and clear white. It is a favorite for canning and freezing.

Snowdrift is one of the newer varieties, and has gained rapidly in popular favor. It requires 60 to 65 days to reach maturity. The plants are larger and more vigorous than Early Snowball. Snowdrift produces a larger head, which is well protected by leaves during the early stages of development yet free of leaflets within the head.

Danish Giant, also called Dry Weather, is a large, midseason cauliflower more adapted to dry adverse weather conditions than the smaller less leafy Snowball types. The heads average about 7 inches and are a good white color. It is grown chiefly in the Midwestern States.

Veitch Autumn Giant is a large, tall-growing, very late variety with upright leaves, requiring 130 to 150 days to mature. The heads of Autumn Giant are the largest of the cauliflower varieties, averaging 8 inches or more in diameter. In the Eastern States it is recommended only as a fall crop.

Winter Varieties

The winter cauliflowers are all very long season varieties, requiring up to 150 days to mature from date of field setting. Their long seasonal requirement limits their production largely to the Pacific coast section of California. The mild climate of the California coastal section permits the growing of cauliflower throughout the winter months. Strains of winter cauliflower have been selected that are suitable for planting at definite dates to give a continuous supply of heads from November to May. Some of the best of these are Early Pearl, Christmas, February, March, St. Valentine, and Late Pearl. The planting dates for the several varieties range from June to November. Early Pearl is suitable for planting in June to mature in November and December. Late Pearl is the latest and is suitable for planting in late October and November for harvesting in April and May.

BROCCOLI VARIETIES

Most of the broccoli grown in the United States is of the Italian Green type, commonly called Calabrese. Strains of this have been selected that range from 50 to 150 days in the time required from date of planting to the time to reach marketable maturity. The several strains differ in color and size of plant, size of head, and extent to which small lateral heads develop below the terminal head. The increasing demand for and interest in broccoli has led to the development of new varieties. Varieties have been developed that are adapted to special growing conditions. Some are better suited for freezing than the older varieties.

The following are some of the best of the broccoli varieties.

Early Green Sprouting is the earliest and one of the best varieties for the early spring market. It is well adapted for the spring crop in some of the eastern broccoli-growing districts where the season is short. This strain is not suited for the late crop or where temperatures are high. It has been widely grown by shippers and market gardeners. Early Green Sprouting forms a compact central head with few laterals. The plants are of medium height, and the foliage is a dark blue green.

DeCicco, one of the newer selections of Calabrese, is a second-early strain, maturing in 55 to 65 days. It produces a large central head followed by many side shoots adaptable for bunching and freezing. The plants are medium tall, light green, and very productive.

Green Sprouting Medium is a large vigorous glaucous-green mid-season selection of Calabrese, requiring 90 to 95 days for maturity. This is the most important shipping and freezing strain and is grown extensively on the Pacific coast and in the Southwest. It is too late to make a good crop in the Northern and Eastern States. The central head is large and compact. After the central head has been harvested, a heavy yield of laterals suitable for freezing can be produced.

Green Sprouting Late is a late, long-season Calabrese, which may require up to 150 days to reach maturity. It is planted mostly in the fall in California for early spring harvest. It is too late to be grown in any of the northern broccoli-growing districts, but may prove to be adapted in some of the South Atlantic States.

Waltham 29 is a new strain of broccoli developed at the Waltham Field Station, Waltham, Mass. It is a uniform, short-season, dark blue-green broccoli, especially suited for the fall crop in the Northeastern and Atlantic Coast States, and is meeting with favor in other areas. It is not recommended for the spring crop. The plants are stocky and produce large, broad central heads. Many later sprouts excellent for freezing develop following the harvesting of the central head.

SOIL AND FERTILIZER NEEDS

Cauliflower and broccoli can be grown successfully on many types of soil, but they reach their highest quality on fairly heavy soil of high water-holding capacity. Good crops can be grown on the lighter soils, provided they are fertile and the plants are well supplied with moisture. Good drainage is essential, but these vegetables, especially cauliflower, must not be permitted to suffer for want of water. The growth of the plant must be rapid and regular. Lack of moisture, poor drainage, or any other unsatisfactory soil condition may upset the development of the plant and cause the premature formation of small heads, or "buttons."

Premature bolting in cauliflower is often associated with lack of nitrogen in the plant tissues. This emphasizes the importance of maintaining the nitrogen supply of the soil. Therefore, it is desirable to use legume crops in the rotation with cauliflower and broccoli. If green-manure crops are used to maintain the soil humus, legumes should be used where they can be worked into the general farm plan.

In order to obtain the necessary rapid, vigorous growth of the plants the soil must be fertile. Barnyard manure is unsurpassed as a source of nutrients for cauliflower and broccoli where it can be obtained in large quantities at reasonable cost. Land for cauliflower production requires as much as 30 tons per acre. Some commercial fertilizers are generally used to supplement the manure even where a large amount is applied. Where manure is not available the organic matter of the soil should be maintained by plowing under green-manure crops and the fertilizing elements should be supplied by commercial fertilizer.

Nitrogen is usually the element most needed in the production of these crops. This is especially true in the Western States. From 1,000 to 3,000 pounds of a complete fertilizer may be used profitably on land for cauliflower. The formula of the fertilizer and the rate of applica-

tion should be determined largely by local conditions and the previous cropping and fertilizing of the land. In general, 10 to 15 tons of manure or a good growth of some green crop and 1,000 to 1,500 pounds of a complete fertilizer containing from 4 to 6 percent nitrogen, 8 to 10 percent phosphorus, and 5 to 7 percent potassium are needed. Supplementing these with one or two side dressings each of 150 to 200 pounds of nitrate of soda, ammonium nitrate, or sulfate of ammonia per acre will give good results.

Some of the less fertile soils in the Eastern States may require larger amounts of fertilizer for maximum yields. Even on fertile land cauliflower usually responds to side dressings of nitrate fertilizer. Nitrate of soda is preferable where the soil tends to be acid. If the soil is very acid it should receive an application of 1,500 to 2,000 pounds of lime per acre well in advance of the planting season.

Heavy fertilization may be less profitable in the production of broccoli than in the growing of cauliflower, since the return per acre may be less.

Some soils may require the application of certain of the minor elements in addition to nitrogen, phosphorus, and potassium for the growing of either cauliflower or broccoli. The most frequently needed minor element is boron, but magnesium and manganese may also be deficient in some soils. A discolored hollow pithy core and discoloration and deformation of the curds are common symptoms of boron deficiencies in cauliflower. Manganese and magnesium deficiency symptoms are somewhat alike, and their identification may require specific tests. Both magnesium and manganese deficiencies are exhibited by a loss of chlorophyll from the areas between the large veins of the older leaves, while the veins themselves remain green. It is wise to have the soil tested for these minor elements. When these symptoms appear it is advisable to consult your local county agent or to obtain assistance from the soils specialists of your State agricultural college.

IMPORTANCE OF GOOD SEED

Seed of a good strain is more essential for the successful production of cauliflower than of most other plants. Prior to 1940 practically all the cauliflower seed planted in this country came from Europe, Denmark, and the Netherlands chiefly. The annual requirement of cauliflower seed amounts to about 15,000 pounds. World War II cut off the European supply and stimulated the production of cauliflower seed grown in the United States. Since 1945 European growers have reclaimed part of the domestic market. However, the United States still produces about two-thirds of its needs.

The best adapted varieties of broccoli have been developed in this country and most of the seed is grown here.

Good cauliflower seed, being difficult to grow, is high priced. However, the small amount of seed required to grow enough plants to set an acre makes the cost of seed a relatively inexpensive outlay. The difference in cost between good and poor seed is more than compensated by the increase in yields to be obtained from high-grade seed of the best strains.

GROWING THE PLANTS

Dates for planting cauliflower and broccoli depend upon the locality, length of time required for the variety to reach maturity, and the season during which it is desired that the crop mature. In California, with its very long growing season, cauliflower is planted from mid-April to late fall, which gives a correspondingly long cutting season. As stated on page 6, several varieties and strains have been selected that are especially adapted for succession planting in the California coastal area. In most of the eastern commercial cauliflower-growing districts the season is too short for the long-season varieties. Most of the crop is of the earlier short-season Snowball types, and is grown largely as a summer or fall crop.

In the important cauliflower districts of California the climate is mild throughout the growing season and most of the plants for transplanting to the field are grown in open beds. In the eastern sections cauliflower and broccoli plants for the spring crop are started in hot-beds or greenhouses, while summer and fall crops are grown from plants started in outdoor plant beds.

Where cauliflower and broccoli plants for transplanting are grown in open beds the seed is planted, usually with a seeder, in rows 12 to 14 inches apart. In some localities the seed is broadcast. The chief objection to the broadcast method is that the soil cannot be properly cultivated to control weeds. The seed should be covered lightly with soil to a depth of a quarter to a half inch. One ounce of seed will produce about 3,000 plants, and 3 to 4 ounces of seed are required to supply enough plants to set an acre. Most growers buy and plant much more seed than is necessary, when properly handled, for adequate supplies of plants.

Plants started under glass for the early crop are grown in flats, benches, or beds, either in rows or broadcast. The seed should be planted thinly so as to give the seedlings ample room to develop. When the seedlings have reached the four-leaf stage they should be pricked out, allowing about 2 inches between plants each way, and permitted to grow until field conditions are favorable for transplanting.

The soil for the growing of cauliflower and broccoli plants for transplanting should be a loose, friable loam but not excessively fertile. Soil that has a tendency to crust on the surface should be avoided. If cauliflower or broccoli plants for field setting are to be grown in beds or frames where plants of any of the cabbage family have been grown in the past, care should be exercised to make sure that such diseases as clubroot, blackleg, black rot, ring spot, and damping-off are not present in the soil. For suggestions on seedbed sanitation, see page 16.

Sometimes cauliflower, and frequently broccoli, is planted with seeders in the field where the crop is to be grown and the plants are thinned to the proper distance when they have reached a suitable size. The thinning should be done before the plants have reached such a size as to crowd. In some cases the planters are set to drop three or four seeds in place where the plants are to stand after thinning. When seeding in place is practiced, early thinning to prevent crowding and root injury to the plants left is very important.

TRANSPLANTING TO THE FIELD

In the West much of the transplanting of cauliflower and broccoli to the field is done by hand. Hand planting is also used on small farms and truck gardens in the East. Many large eastern growers use plant-setting machines equipped to apply a small amount of water with each plant.

In most of the important production centers cauliflower and broccoli plants are set in rows 2½ to 3 feet apart. The distance between plants in the row varies greatly, depending upon the variety or strain grown. Some of the smaller, upright-growing strains are set as close as 15 inches apart in the row. The late, large strains are set 2 to 3 feet apart in the row. The latter distances are used generally throughout the western sections.

Cauliflower is less hardy to cold than cabbage and should not be set in the field as long as there is danger of killing frosts. The stunting of cauliflower plants by cold tends to induce premature heading, and small unmarketable heads result. Broccoli is less likely to suffer from the effects of low temperatures after setting than cauliflower, but freezing weather should be avoided.

CULTIVATION AND IRRIGATION

Cultivation should be frequent enough to prevent weed growth and surface crusting. For either weed control or mulching the cultivation should be done with proper implements and should be shallow. Cultivation deep enough to cause frequent or severe root injury should be avoided, especially during the later stages of growth.

Except in districts where rainfall can be depended upon to be sufficient and properly distributed during the growing season to maintain the required moisture level for cauliflower, some provision should be made for irrigation.

The cauliflower plant will not produce a good commercial head if it is permitted to suffer for want of water. Broccoli can be grown under less favorable moisture conditions than cauliflower. Practically all the cauliflower and broccoli produced in the Western States are grown under irrigation. Much of the eastern crop is grown without any supplemental irrigation, and it is frequently injured by drought.

BLANCHING, HARVESTING, AND PACKING CAULIFLOWER

The heads, or curds, of cauliflower, when properly grown, are snowy white; the market demands a white product. When in prime condition for harvesting, they are fully developed, compact, and clear white, and they must be free of any discoloration (fig. 2, *B*). Over-maturity results in an open head and destroys its salability (fig. 2, *C*).

Cauliflower is not only unattractive but often develops an undesirable flavor if grown exposed to sunlight. Discoloration lowers the grade and consequently reduces the price. While they are still small the curds are well protected from the sun by the small incurved leaves surrounding the head. As the head enlarges the protecting

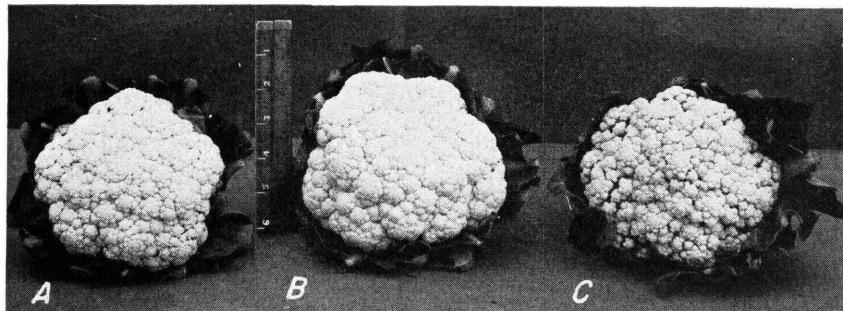


FIGURE 2.—Cauliflower heads showing three stages of maturity: *A*, Just past prime condition but still salable; *B*, in prime condition for marketing; *C*, too old and unsalable.

leaves are forced apart, leaving the curds protected from light only by the large outer leaves. In some large, late varieties in which the leaves are very long and upright, the curds are fairly well covered and often no artificial protection is required, especially if the crop matures during cool weather. The developing heads of short-leaved and spreading varieties of the Snowball type are protected from sunlight by gathering the longest leaves together over the head and tying them with a soft twine, raffia, or tape (fig. 3). Because the plants do not all develop heads at the same time, it is necessary to go through the field every 2 or 3 days to tie each plant when the head begins to show through the small central leaves surrounding it. In order to have some convenient label on the plants tied at one time, a different-colored tying material may be used for each tying date. If the tying is done regularly and when the heads are at the same stage of development, most of the heads tied with a given color of string on one date will be ready for harvest on the same date. This device eliminates unnecessary examination of tied plants that are not nearly ready for harvest.

After being tied, a few heads should be examined daily to make certain that they do not become overdeveloped. Overdeveloped heads have little or no market value (fig. 2, *C*). On the other hand, there is danger of sacrificing size and weight if the harvesting is done prematurely. It is better to cut a little early than too late, for even slight overmaturity reduces quality (fig. 2, *A*). The most desirable size is about 6 inches in diameter. Unless the plants are large and have made a good vigorous growth, large heads cannot be obtained by delayed harvesting. The time required for the heads to reach the proper stage of maturity after they are tied depends very largely upon the temperature. If the temperature is high, less time will be required than if it is low. In warm weather cauliflower may reach marketable maturity within 3 to 5 days after being tied, but in cool weather, when the growth rate is slow, as much as 2 weeks may elapse before the heads are ready to harvest. The grower should learn to judge the maturity of the cauliflower head by its appearance rather than depend entirely upon size or time elapsing from date of tying.

At harvest cauliflower heads are cut from the plant with a large



FIGURE 3.—A cauliflower plant tied for blanching.

knife, leaving one or more whorls of leaves attached to protect the curds. In the large production districts the cut heads are usually hauled to a central packing shed, where they are graded, trimmed, and packed, usually in crates. In some districts the packing is done in the field.

Various sizes and shapes of containers are used for shipping. Most of the western cauliflower crop is shipped in the pony, or flat, crate holding one layer of heads. New York growers also use a one-layer pony crate, but other kinds of containers are in general use. Four-

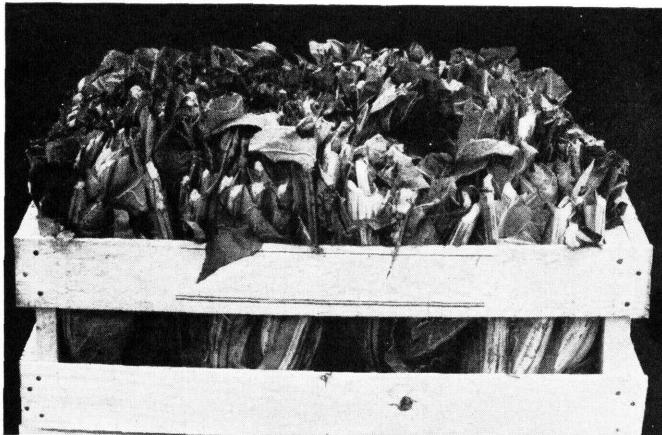


FIGURE 4.—A crate of cauliflower trimmed and ready to be lidded.

basket tomato crates, egg and orange crates, bushel baskets, and other types of containers are often used for short hauls and local markets.

Where the flat, or pony, crate is used, the heads with a few leaves attached are packed erect in the crates and the foliage is then cut off with a large knife, leaving a bulge of about 2 inches at the center (fig. 4). Regardless of the type of container the leaves are usually cut off just above the head, leaving a jacket of petioles and part of the leaf blades to protect the head.

HARVESTING AND PACKING BROCCOLI

Unlike cauliflower, broccoli requires no blanching; hence, tying to protect the heads from light is unnecessary. Overmaturity reduces or destroys the commercial value of broccoli; therefore, it should be cut before the flower heads have opened enough to show the yellow petals (fig. 1). Overmaturity also tends to cause a woodiness of the outer tissues of the stems, which is very undesirable. When the heads have reached the proper stage they should be cut with 8 to 10 inches of the stems. The cut heads and stems are usually tied in bunches in a manner similar to bunched asparagus and packed in crates, hamper, or other suitable containers. A crate in common use in New York measures $13\frac{1}{2}$ by 22 by 10 inches and holds 18 bunches. Hampers are in general use in the South.

A second cutting of broccoli is sometimes obtained from lateral shoots that develop after the central flower cluster has been removed at the first cutting. While the central cluster of flowers may measure 3 to 6 inches at the proper stage of maturity the laterals develop much smaller clusters, measuring from 1 to 3 inches in diameter. The lateral heads may be bunched together or combined with central clusters maturing at the same time; however, the small lateral clusters are not so desirable as the large central ones and their inclusion with the latter may reduce the market value of the bunches. Small heads produced on the laterals are desirable for freezing.

INSECTS AND THEIR CONTROL

The insects that cause the most damage to cauliflower and broccoli are several kinds of caterpillars, cutworms, and aphids, and the cabbage maggot.²

Precautions in Handling Insecticides

Most insecticides are poisons. Handle them with great care. **Follow the directions on the package.** Store all insecticides in closed containers, where they cannot be mistaken for food or medicine, and where children or farm animals cannot reach them. See that the containers are properly labeled.

Parathion is an extremely dangerous poison. It should be used only by trained operators, who will assume full responsibility and enforce proper precautions as prescribed by the manufacturers. A person applying it should wear a tight-fitting gas mask or respirator equipped with a canister specified for use in handling organic vapors, acid gases, and dusts.

Parathion, malathion, and toxaphene are absorbed through the skin. A person handling these materials should wear protective clothing, keep the shirt buttoned at the neck, keep the sleeves rolled down, and bathe and wash clothing daily.

Caterpillars

The principal caterpillars that cause damage to cauliflower and broccoli are the cabbage looper, the imported cabbageworm, the diamondback moth, the cabbage webworm, the cross-striped cabbageworm, the corn earworm, and climbing cutworms. The first three species are predominantly green, and the other species are brown, black, or gray, sometimes with colored stripes. They range from $\frac{1}{3}$ to 2 inches long when full grown. All these caterpillars are the immature stages of moths or butterflies. They injure cauliflower and broccoli by eating holes in the leaves, by destroying the growing buds, or by tunneling into the heads of the older plants.

You can control these caterpillars with a spray or dust. On young plants use DDT, toxaphene, or cryolite, but after the plants begin to head use rotenone or pyrethrum to avoid harmful residues on the marketed vegetables.

² The full names of the insects mentioned in this bulletin are as follows:

Common name	Scientific name
Cabbage looper-----	<i>Trichoplusia ni</i>
Imported cabbageworm-----	<i>Pieris rapae</i>
Diamondback moth-----	<i>Plutella maculipennis</i>
Cabbage webworm-----	<i>Hellula undalis</i>
Cross-striped cabbageworm-----	<i>Evergestis rimosalis</i>
Corn earworm-----	<i>Heliothis armigera</i>
Cabbage maggot-----	<i>Hylemya brassicae</i>
Cabbage aphid-----	<i>Brevicoryne brassicae</i>
Turnip aphid-----	<i>Rhopalosiphum pseudobrassicae</i>
Black cutworm-----	<i>Agrotis ypsilon</i>
Granulate cutworm-----	<i>Feltia subterranea</i>
Variegated cutworm-----	<i>Peridroma margaritosa</i>

Dusts containing the following percentages of these insecticides can be purchased for use without further dilution:

DDT, 5	Rotenone, 1
Toxaphene, 10	Pyrethrum, pyrethrins, 0.3
Cryolite, sodium fluoaluminate, 90	

A dust mixture containing 0.5 percent of rotenone and 0.15 percent of pyrethrins is also available.

If you prefer a spray, buy a powder or liquid concentrate and add the quantities given below to 100 gallons of water.

DDT:	
50-percent wettable powder-----	2 pounds.
25-percent emulsifiable concentrate-----	1 quart.

Toxaphene:	
40-percent wettable powder-----	6 pounds.
75-percent emulsifiable concentrate-----	1½ pints.

Cryolite, sodium fluoaluminate 90 percent-----	6 pounds.
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Rotenone: Use 5 pounds of derris or cube powder, containing 5 percent of rotenone, and add 2 pounds of nonalkaline soap flakes or a wetting agent as directed on the package. You can also obtain a liquid concentrate containing rotenone or pyrethrum or a mixture of these insecticides. Dilute with water as directed on the package.

Make the first application when there is about one caterpillar per plant or when one-fourth of the plants show signs of feeding, and repeat every 10 days if necessary.

The rate at which to apply dusts or sprays will depend on the type of equipment used, the size of the plants, and the choice of the insecticide. All parts of the plants above the soil surface should be covered. The following dosages per acre are recommended:

	Dusts	Sprays
DDT, toxaphene, or cryolite-----	20 to 25 pounds	50 to 100 gallons
Rotenone or pyrethrum-----	25 to 30 pounds	75 to 125 gallons

Cutworms

Cutworms are stout, soft-bodied, smooth, and cylindrical. They may be gray, brown, or nearly black, with spots or stripes. They hide in the soil during the day and come out to feed at night. Sometimes they destroy cauliflower and broccoli plants soon after they have been transplanted to the field. These pests can be controlled readily with dust, spray, or poison bait.

Dusts.—Treat the soil surface with 10-percent toxaphene or DDT dust at the rate of 20 pounds to the acre (½ pound to 1,000 square feet).

Sprays.—Apply to the soil surface a spray containing 5½ pounds of 40-percent toxaphene or 50-percent DDT wettable powder in 100 gallons of water at the rate of 100 gallons per acre (6 level tablespoonfuls in 2½ gallons of water to 1,000 square feet).

If the crop has already been planted, apply the insecticide around and between the plants. Do not disturb the soil for several days, as cutworms are killed when they crawl over treated soil at night.

Baits.—You can buy a ready-mixed cutworm bait or mix your own with the following materials:

Dry wheat bran-----	25 pounds.
Toxaphene (40-percent wettable powder)-----	2 pounds.
or sodium fluosilicate or paris green-----	1 pound.
Water-----	3 gallons.

Thoroughly mix the poison with the bran slowly while stirring. Mix on some flat, smooth surface with a shovel, and rake in much the same way as in mixing concrete. Place the mixture in a washtub and add the water slowly, stirring all the time. Use only enough water to make a crumbly mass. It is a good plan to set aside a little of the dry mixture in case you have used too much water.

To make only a small quantity of bait, mix proportionate amounts of these materials in a bucket.

Either broadcast the poisoned bait or sow it by hand along the rows or about the base of the plants, being careful not to get it on the plants. Do this late in the evening.

Use 20 pounds of the wet bait per acre (or about $\frac{1}{2}$ pound to 1,000 square feet) if you broadcast it. If you apply it directly to the rows or hills, a smaller quantity is sufficient. Two or three applications 2 days apart may be necessary to rid the field of the pests.

Aphids

Turnip and cabbage aphids are similar tiny, soft-bodied, insects that suck the juices from the plants. They can be controlled with nicotine, malathion, or parathion. It is especially important to start treatments as soon as the first infestation is evident. The infested leaves soon crumple and curl downward around the insects, so that it is difficult to reach them with dust or spray.

The first few scattered aphid infestations in a field can often be cleaned up by applying a 3-percent nicotine dust with a hand duster.

In fields of more than 2 or 3 acres where the infestation is general, a power or traction duster or sprayer can be used more effectively. Apply a 1-percent parathion dust or a 4- to 5-percent malathion dust at the rate of 30 pounds per acre. For a spray use $1\frac{1}{2}$ pints of nicotine sulfate (40-percent nicotine) and 4 pounds of soap in 100 gallons of water. Apply at the rate of 100 gallons per acre, as soon as the insects appear.

Do not apply malathion within 10 days of harvest or parathion within 21 days of harvest to avoid harmful residues on the marketed vegetables.

See caution regarding use of malathion and parathion on page 13.

Cabbage Maggot

Cabbage maggots are the young of small flies that resemble house flies. The eggs are laid around the roots of the plants soon after they are set, and the maggots that hatch from these eggs gnaw off the surfaces of the stems and bore into the larger roots and the lower part of the stalks.

You can prevent damage by the cabbage maggot in the early stages of plant growth by applying a chlordane spray in the plant bed when the first two leaves appear. Use a 5-percent dust or a spray containing 4 pounds of 50-percent wettable powder or 1 quart of 75-percent emulsifiable concentrate in 100 gallons of water. Apply sufficient dust or spray to cover the plants thoroughly.

If cabbage maggot infestations occur at transplanting time, add $2\frac{1}{2}$ level tablespoonfuls of the wettable powder or 2 teaspoonfuls of the

emulsifiable concentrate to each 4 gallons of transplanting water, and use $\frac{1}{2}$ teacupful of this water where each plant is set in the soil.

If infestations develop after the plants are in the field, apply the chlordane dust or spray mentioned for use in the plant bed. Use 40 pounds of the dust and 100 gallons of the spray per acre. Be sure to cover the bases of the stalks thoroughly with the insecticides.

METHODS OF CONTROLLING DISEASES³

The diseases of cauliflower and broccoli, which are common to cabbage, are described in detail in Farmers' Bulletin 1439, Diseases of Cabbage and Related Plants. Those which affect these two crops most seriously are mosaic, black rot, blackleg, clubroot, damping-off, and ring spot. Since varieties resistant to any of these diseases are not available, the approach to their control is through preventive measures.

Use of Disease-Free Seed

Blackleg and black rot organisms are carried on and in the seed. Since 1939 most of the seed of cauliflower and broccoli has been grown in Pacific coast districts where these two diseases do not affect the seed plants. Where the grower cannot be sure of the source of the seed, the germs can be removed by seed treatment. Treatment with mercuric chloride or with fungicidal dusts is not adequate to control blackleg and black rot. The only known effective treatment is the use of hot water. Seed is placed in very loose muslin bags and inserted in a constant-temperature bath at 122° F. for 30 minutes. If seed is old or weak, the germination will be reduced by this treatment; therefore, it is necessary to make a preliminary run on each seed lot to determine whether it will stand the treatment. Because of this treatment hazard, seed from the Pacific coast is far preferable to treated seed. Dusting the seed with Semesan may help germination somewhat. However, it is not a substitute for the hot-water treatment. The hot-water treatment must be used if any seed grown east of the Rocky Mountains is to be safe from blackleg and black rot organisms.

Copper dusts should not be used on cabbage or broccoli seed.

Seedbed Sanitation

Most of the germs of the diseases mentioned on this page live over in the soil. Repeated use of the same soil in coldframes or seedbeds of any type is unwise. Outdoor seedbeds should be rotated, and soil in hotbeds or coldframes should be treated by one of the standard methods. The mosaic viruses live over in weeds belonging to the cabbage family and some other plants from which they are carried to the seedbed by aphids. Avoid placing seedbeds near weedy borders and keep coldframe areas free from weeds. In areas near the Pacific coast where ring spot is severe, clean up promptly cabbage, cauliflower, and broccoli refuse, since airborne spores of this disease are discharged and air currents may carry them long distances.

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